1 Document Control

Work Category No.	215 – STRUCTURES COMPONENT REPLACEMENT				
Sub-category Description	215F - GUARDRAIL AND BARRIER COMPONENT REPLACEMENTS (NOT ON BRIDGES)	Quality Assurance Statements			
Author:	s 9(2)(a)	Capital Journeys Marine Parade Petone Wellington PO Box 38 208 Wellington Mail Centre 5045		Prepared by	Date
Owner (NZTA)	s 9(2)(a)			s 9(2)(a)	
Audience:	NZTA; Capital Journeys			Reviewed by	Date
Stakeholders:	NTA; Capital Journeys			s 9(2)(a)	
Status:	DRAFT				
Distribution:	s 9(2)(a)				
Security:	Open	Version	Dates	Purpose	
Document purpose:	Support Annual Plan Submission	0.1	13/9/16	Document creation	
Document linkage:	2017/18 Annual Plan	0.2	9/12/16	General revision	
Document expiry:	February 2017	0.3	24/01/17	General revision	
Key Words:	AP17/18				

2 Activity Summary

Summary of Proposed Activities

Purpose Statement

Road safety barriers are designed to contribute to road safety outcomes by containing and redirecting errant vehicles and thereby preventing them from leaving the road or crossing into the path of oncoming traffic. They also contribute to a forgiving roadside environment reducing the probability of a fatality or serious injury to the occupants when a vehicle leaves the highway.

Road safety barrier systems of varying design and age are distributed across the network providing side protection, end protection and median barrier protection to our customers. With recent changes in the type of road safety barrier systems being used, combined with the Government Policy Statement (GPS) to deliver better safety outcomes, this is an asset type that is growing each year. And as road safety barrier system technologies and specifications have continued to change, older existing installations have become non-compliant.

There have been two examples since August 2016 of serious failure of concrete new jersey barrier in the Wellington network. Both failures lead to significant hazards with concrete barrier units falling over onto a live railway and over onto the right hand shoulder/lane of State Highway 2 Hutt Road.

The first example of a recent failure is the New Jersey Barrier (NJB) in Silverstream on the 8th of August. The barrier was struck by a vehicle which resulted in a length of Barrier twisting free from its footing and swinging into the path of the rail corridor and road way shoulder. The NJB was found to have inadequate inter-barrier and footing connection, remedial repair included re-doweling the barrier to the footing and fitting connection plates over both ends of the barrier have been completed.

Summary of Proposed Activities

The second example occurred on the median New Jersey Barrier of State Highway 2 Hutt Road running from RP12,929m to 14,514m on the 11th of November 2016. The barrier was struck by a light passenger vehicle and toppled over immediately behind the right hand edge line of the southbound traffic lanes. This occurred at the start of the morning peak traffic period and was a significant hazard to vehicles travelling in the right hand lane in both directions. Fortunately peak travel speeds were relatively slow but, the traffic volume was high. The barrier was subsequently righted and placed back into position

In both examples the New Jersey Barrier units were not connected to the adjacent units and ground pins were in poor condition, rusted and only embedded in the in-situ ground. This resulted in there being no ribbon strength along the length of the new jersey barrier or ability of the individual units to resist the impact loads.

There are substantial lengths of new jersey barriers installed on the Wellington highway network, much of which has been in place for 40 years or more. New jersey barrier units are installed on SH1 Shell Gully, SH2 Hutt Road, SH2 Silverstream, and SH1 Porirua.

The new jersey barriers are a non-compliant system under NZTA M/23 and have less steel reinforcementthat the complaint F-Type concrete barriers. The profile of the new jersey barriers have a higher 'break' point and are more likely to induce a vehicle to roll over in the event of an impact. The lack of connections between the pre-cast units and foundations have resulted in the new jersey barriers being less resistant to impacts than M/233 compliant systems, as shown in the two examples.

In the last five year period there have been 48 crashes involving vehicles hitting a central new jersey barrier within the sites identified for renewal in the 2017-2020 programme. Most of these crashes have had minimal impact on the existing new jersey barriers, though there have been some units where they have shifted laterally. A complete failure of the barriers, as shown in the two examples, is considered to be a low probability but high consequence risk.

Although there have been a number of crashes where vehicles have struck central new jersey barriers without significant failure, the recent performance of the new jersey barriers in the two examples show that it cannot be guaranteed that the barriers will perform as required when the barrier is struck. This potentially allows an errant vehicle onto the oncoming traffic or having the barrier unit's themselves being moved into the oncoming traffic lanes.

The 2017-2020 programme has identified the existing new jersey concrete barrier used as the central median barrier along the Wellington network where a barrier failure will have a significant risk to other traffic or consequence to the highway network.

There are limited options to improve connection between units or improve foundations of existing new jersey barriers and these would not result in a M/23 compliant barrier system. These options such as steel connecting plates between units and anchor bolts to improve foundations will introduce additional hazards from the 'protrusions' of bolts and connecting plates. These 'protrusions' will create surfaces that may catch a vehicle during a crash potentially exacerbating the consequence of a crash and affecting the performance of the barrier units. Rehabilitation or improvements to the existing new jersey barrier units do not provide the same level of assurance that the system will respond as required as a full renewal.

On the 28th of June 2015 a fatal crash occurred on the exisiting median new jersey barrier between the Terrace Tunnel and Shell Gully Overbridge at SH1N RS1068 RP5.316 – D. The motorcyclist and passenger were thrown off when the motocycle slid/scrapped along the new jersey barrier and the handle bars struck an old pole support on the top of the barrier, causing the motorcycle to suddenly turn right into the barrier. Installation of connecting plates along the median barrier could present a similar hazard.

Summary of Proposed Activities

The estimated cost to improve the connection and foundations of the existing new jersey barrier units is s 9(2)(a) per linear metre. This estimate is based on installing a 750mm long galvanised steel plate over each connection between the barrier units connected to the units with anchor bolts and drilling six 750mm long ground pins through each barrier unit into the ground.

The estimate of s 9(2)(a) per linear metre for improving the existing barriers is based on a conceptual design only that has not gone through the full design process. The estimate for complete renewal of the existing new jersey barriers is $2,000 per linear metre.

The table below compares the estimated costs for full renewal and improvements to the connection for the proposed sites in the 2017-2021 programme.

Year	Proposed Length	Full Renewal Estimated Cost	Connection Improvements Estimated Cost
2017-2018	3,041m		
2018-2019	591m		
2019-2020	1,435m		
2020-2021	792m		

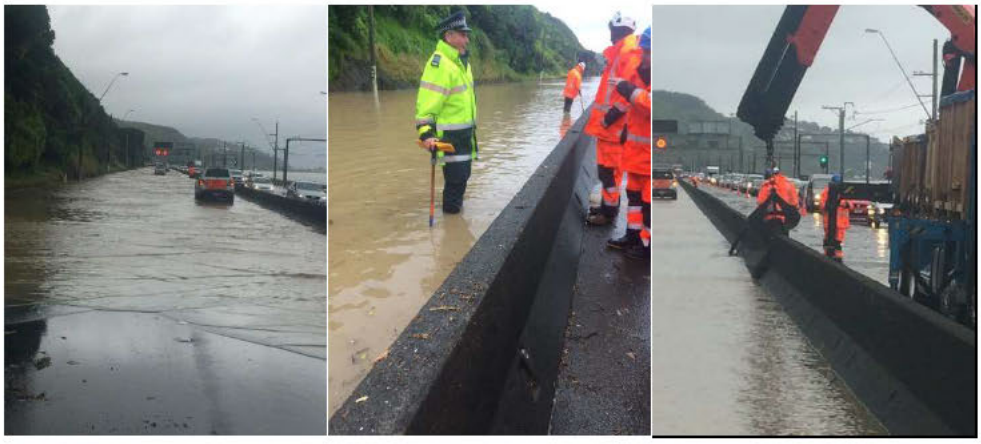
s 9(2)(ba)(ii)

Improvements to the existing new jersey barriers do present a significant saving compared to full renewal with new slip form barriers. However, NZTA will need to accept the risks associated with improving the exisiting barriers such as being non-compliant with M/23 and the 'protrusions' of bolts and connecting plates further impacting barrier performance.

For the purposes of the Annual Plan we have requested funding for full renewal due to improvements still leaving a non-complaint systems in a high risk environment.

Furthermore, during the rainfall event on the 15th of November the new jersey barrier in the median of State Highway 2 RS962/12.85-I acted as a dam preventing water from draining from the road surface, due to insufficient drainage at the base of the barrier units.

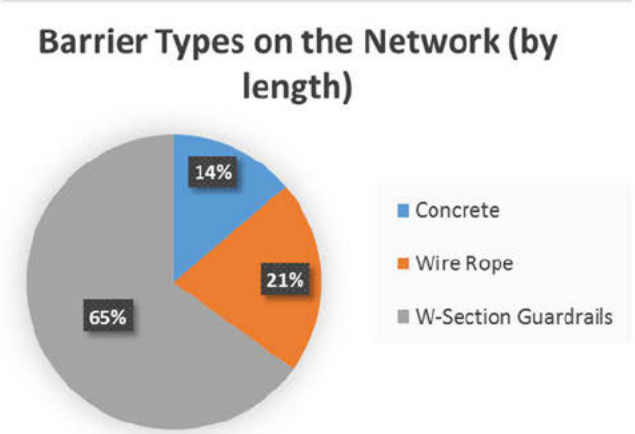
Remedial solutions to improve connections between the barrier units will prevent individual units from being lifted in similar events to allow flood water to be drained, as shown in the photo below. Where as the full renewal option allows for an oppurtunity to improve the drainage capacity and reduce the likelihood of further flooding.



There are also lengths of w-section guardrail that are in poor condition, showing signs of rust and/or deteriorating posts. Additional to this, there are substantial lengths of non-compliant guardrail on the network, particularly in terms of height. Both the poor condition and compliance are outcomes of the historic under-investment in barrier renewals.

Wire rope barriers have been installed along various locations in the network. The older wire rope barriers are showing signs of rusting in the base of the posts. Questions have also risen about the condition of the wire ropes and the impact of fatigue imposed

Summary of Proposed Activities
by the yearly wire rope tensioning. Although no wire rope barriers have been included in 2017/18 wire rope barriers are included in the subsequent years. It is critical that compliant barrier systems are used and acceptable condition is maintained across the network in order to limit the consequences of crashes in these areas. Barrier renewals is an area that has historically been under-invested on the Wellington network, particularly in recent years. There is subsequently a backlog of renewals work required to ensure that this high traffic network remains safe for road users.

Description:	RPs	Locality	Link to Pavement & Surfacing Renewal Site (where relevant)
There are three main categories of barriers on the network: • Concrete barriers • Wire rope barriers • Steel guardrails The graph below shows the percentage of each type of barrier, by length. 	Various	Various	Where AWPTs or surfacing overlays are being completed on the adjacent carriageway, barriers will be lifted as necessary to ensure height compliance.

Customer Levels of Service that the activity delivers – *strike out where not relevant*	• ~~Mobility (traveltime reliability, resilience of the route)~~ • Safety • ~~Amenity (travel quality and aesthetics)~~ • ~~Accessibility (land access and road network connectivity)~~

3 Previous & Current Annual Plan Funding Requests, and Forward Programme

Funding levels by year ($,000)													
	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28
Current Request			6,534	1,906	3,372	2,351	2,612	2,612	2,612	2,612	2,612	2,612	2,612
Previous Request	475	390.3	300	300	300	300	300	300	300	300	300	300	300
Previous Allocation	0	139.8											
Previously Spent	0												
BRPQs (where relevant)													

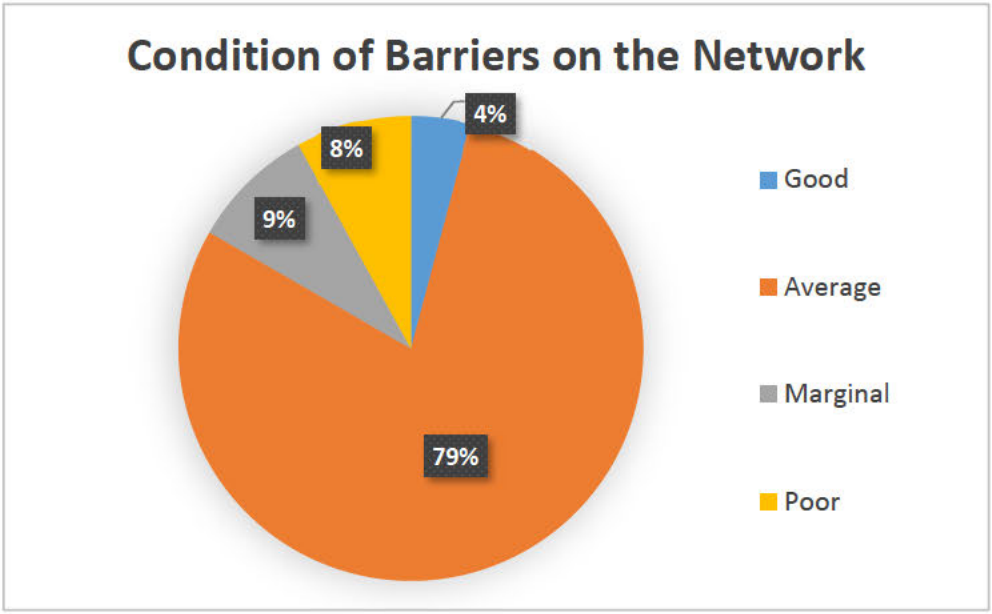
BRPQ's													
Delivered /Planned Quantity													

4 Achieving Levels of Service and OPMs

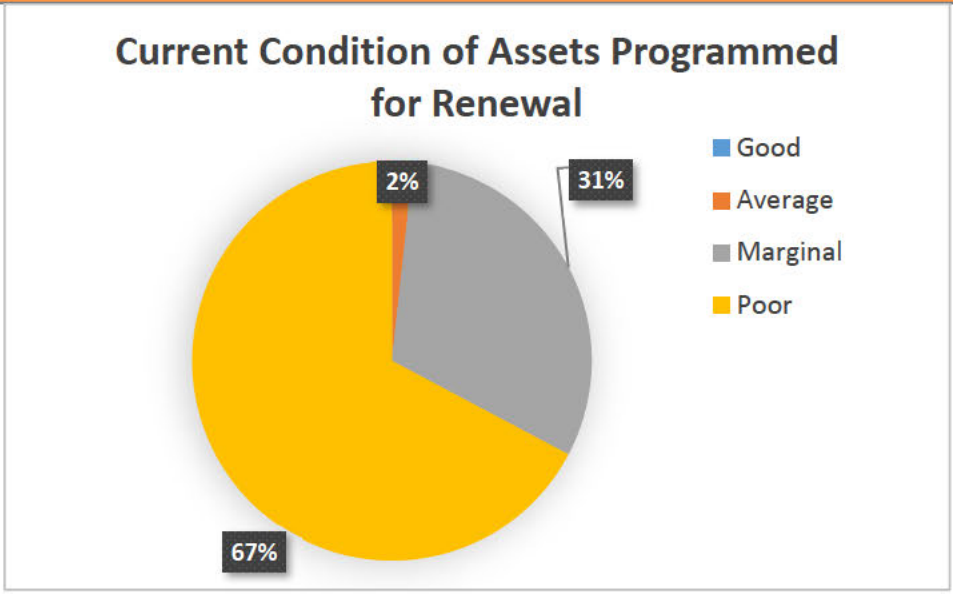
MMP Processes	
Relevant MMP Section	16.3 Development of the Forward Works Programme
Global Condition Summary	As outlined in the MMP, the condition score indicates the structural condition of the asset and gives it a rating between 1 (sound) and 5 (very poor). The condition scoring system in the MMP has been modified slightly and the condition used for each barrier is outlined below.

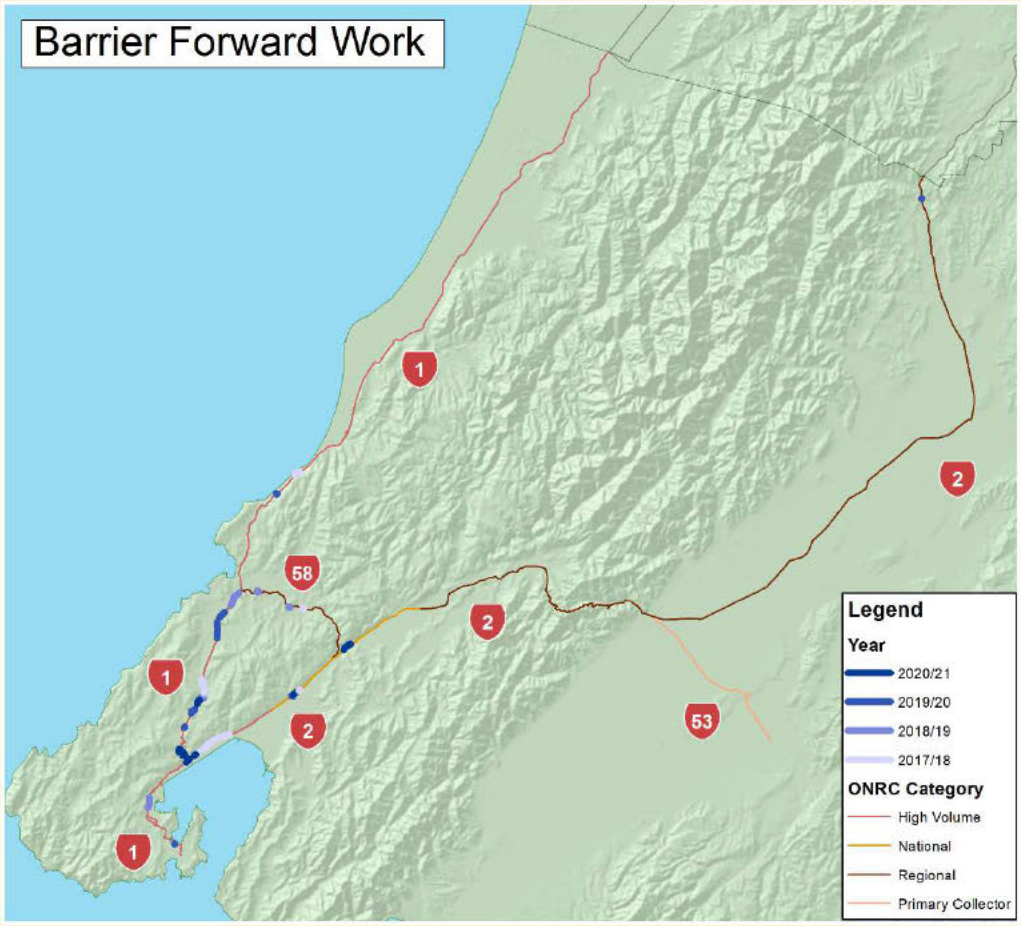
Score	Condition	Description
1	Good	New or near new asset with no defects
2	Average	Asset > 5 years old but still in good condition
3	Marginal	Asset in average condition showing some very minor defects
4	Poor	Asset is below average condition appearing to require replacement in 5 years.
5	Very Poor	Old and defective asset requiring imminent replacement, or non-compliant asset (such as fishtail or Texas Twist terminal) or incorrectly installed asset

A graph showing the condition of guardrail and barrier assets is shown below. Although the majority of assets are in average or good condition, 17% are in Marginal and Poor condition. No guardrails or barriers have been rated to be in very poor condition.



The current condition of barriers programmed for renewal in the FWP for 2017/18-2020/21 is included in the graph below. Some assets in average condition are programmed for renewal for other reasons such as height non-compliance. The FWP for 2017/18-2020/21 allows for renewal of 79% of all poor condition assets and 34% of all marginal condition assets.

MMP Processes	
	
Prioritisation	The Guardrail renewals prioritisation is based on: • Condition • Crash Risk • Extent of any height non-compliance as outlined in the MMP. The crash risk has been calculated for each site taking into account the KiwiRAP Collective and Personnel Crash Risks. The resulting prioritisation scores range from 7.3 (highest priority) to 1.7 (lowest priority). The Remaining Life and Environmental Risk factors included in the MMP have been excluded from the prioritisation, following discussion and agreement with the NZTA Asset Owner. These factors were dropped as they were prioritising guardrails that, upon inspection, were considered to not require renewals during the Annual Plan period. These sites were incorrectly prioritised as most rails do not have an installation age recorded in RAMM and by default are considered near end of life and it appears the Environmental Risk does not accurately reflect the actual environmental conditions. This issue will be reviewed more thoroughly during the next update of the MMP. The 2017/18 and 2018/19 FWP sites particularly focus on replacing poor condition barriers and marginal condition barriers with non-complaint heights on sites with a moderate to high crash risk. The compliance of guardrails is a secondary consideration in forming the barrier renewal programme. Due to the historic under-investment in barrier renewals poorer condition guardrails have been prioritised first, with height non-compliance used as a prioritisation factor in developing the programme from 2019/20 onwards. Where low guardrails coincide with pavement renewals and resurfacing works these have been included in the FWP to co-ordinate guardrail renewals with the pavement works. Future capital works have also been considered in the development in the programme. Where a barrier with an high score under the MMP process are within a future capital project site these have been excluded from the programme. An example is the existing median concrete new jersey barrier on State Highway 2 RS962 from 11928m to 12332m which has an MMP score of 7.3, the highest overall, but is within the Petone to Grenada project site.

Optimising activities to ONRC levels	
	Renewals are concentrated on high classification routes and locations of high crash risk. The majority of sites included in the 2017/18 AP and three year funding block 2018/19-2020/21 are on NSH (+HV) and RSH routes.

5 Sensitivity Assessment

Risk(s) to Levels of Service and OPMs	
Reduced Funding	Increased Funding
Based on condition and non-compliance, barrier renewals is an area that is already under-invested. If funding is reduced the amount of renewals will be subsequently reduced, leading to barriers that are likely to not perform as required to safely contain or redirect a vehicle if struck. The sites identified, particularly the concrete new j jersey barriers, are at risk of failure and are considered likely to cause	Increased funding would allow for all guardrails that have a condition rating of poor (condition 4) to be replaced (additional 2,754m length) with estimated cost to replace of $908,820. It would also allow for replacement of additional New Jersey Concrete Barrier length that is located along the sides of the carriageway, as opposed to along the median (additional 350m length) with estimated cost of $700,000.

Risk(s) to Levels of Service and OPMs	
Reduced Funding	Increased Funding
significant safety consequences, such as tipping over into live traffic lanes and rail corridors.	

6 Programme Schedule

Notes:

- tables below to cross refer to spread sheet where renewals tab contains the detail
- tables below to only contain activities that are agreed with and endorsed by the NZTA programme owner
- identify the activities that would not be done if funding reduced by 10%, and the additional activities that could be done if funding is increased

2017/18			
SH/RS/RP	Activity	Priority (from MMP)	Cost
SH1N various	W Section Guardrail replacement (1,262)	5.4 to 6.6	s 9(2)(ba)(ii)
SH2 various	New Jersey Barrier replacement (3,041m)	5.4	
SH2 various	W Section Guardrail replacement (118m)	6.1	
SH58 various	W Section Guardrail replacement (227m)	6.3	
		Total Cost in year	

2018/19			
SH/RS/RP	Activity	Priority (from MMP)	Cost
SH1N various	New Jersey Barrier replacement (591m)	6.6	s 9(2)(ba)(ii)
SH1N various	Wire Rope Barrier replacement (1,437m)	4.4 to 5.4	
SH1N various	W Section Guardrail replacement (451m)	6	
SH58 various	W Section Guardrail replacement (128m)	6.1	
		Total Cost in year	

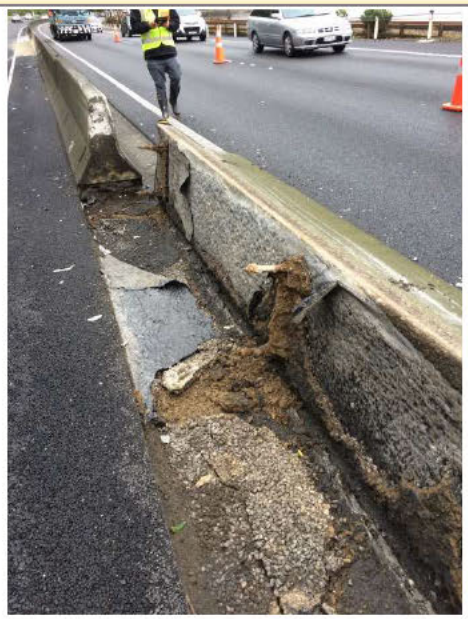
2019/20			
SH/RS/RP	Activity	Priority (from MMP)	Cost
SH1 various	Wire Rope Barrier replacement (632m)	4.4 to 5.4	s 9(2)(ba)(ii)
SH1 various	W Section Guardrail replacement (1,154m)	3.7 to 6	
SH1 various	New Jersey Barrier replacement (1,435m)	5.4	
SH2 various	W Section Guardrail replacement (142m)	4.1 to 5.1	
		Total Cost in year	

2020/21			
SH/RS/RP	Activity	Priority (from MMP)	Cost
SH1N various	W Section Guardrail replacement (1,297m)	4.4 to 6	s 9(2)(ba)(ii)
SH2 various	W Section Guardrail replacement (1,028m)	4.1 to 5.3	

SH2 various	New Jersey Barrier replacement (792m)	5.4		s 9(2)(ba)(ii)
		Total Cost in year		

7 Supporting Evidence Base

Links to detailed build-up of programme
Contract Workspace Links
Link 1 – Programme Spreadsheet Link 2 – MMP Proritsation Spreadsheet
Add additional lines as required

Sample Photographs		
	Photograph	RS/RP
Example 1	 Toppled New Jersey barrier unit showing minimal embedment and founding of the barrier units, significant lengths of this type of barrier have historically been installed in the Wellington network.	SH2-RS962/12.85-I 12,929m to 14,514m

Sample Photographs		
	Photograph	RS/RP
Example 2	 Lack of mechanical connection between pre-cast concrete new jersey barriers and thus not allowing transfer of impact load along the length of the barrier	SH2-RS962/12.85-I 12,929m to 14,514m
Example 3	 Lengths of w-section guard rail showing surface rust and older aged posts	SH01N-RS1050-I 9164m to 9628m

Sample Photographs		
	Photograph	RS/RP
Example 4	 Lengths of w-section guard rail showing surface rust and older aged posts	SH01N-RS1050-I 9164m to 9628m
Example 5	 Extensive rust along back of w-section guardrail	SH01N-RS1035/0.154-D 1801m to 2309m

Sample Photographs		
	Photograph	RS/RP
Example 6	 Rust extending to front face of the guardrail around bolt connections	SH01N-RS1035/0.154-D 1801m to 2309m
Example 7	 Non-compliant low guardrail height	SH58 RS000/10.13 12767m to 12994m
Add additional lines as required		